ABSTRACT

Title of Document:	DETACHED EDDY SIMULATIONS AND ARTIFICIAL NEURAL NETWORK TRAINING ON A DATA CENTER RACK
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The data centers are integrated IT systems that house multiple-unit servers which are intended for providing various internet application services. The power consumption of such large systems has triggered the alarm by Environment Protection Agencies. To reduce the energy consumption, a real-time control framework based on various thermal parameters is imperative.

The raised floor plenum data centers are highly dynamic because of cold-hot aisle arrangements and time-dependent server heat generation. A large number of variables affect the performance of the data center and allow investigation of real-time thermal management. Therefore, Computational Fluid Dynamics (CFD) simulations are majorly used for the analysis of thermal and air flow inside the data centers.

In this study, rack level CFD analysis of the data center was performed using the Eddy Viscosity Model (EVM) based on *k-ε* and Detached Eddy Simulations (DES)

techniques. DES combines good features of both URANS & LES, concomitantly provides better results compared to the k-ε model.

Initially, the average rack inlet and outlet temperatures in steady state CFD model were validated with experiments within the accuracy of 1.4 °C. Then transient CFD simulations were performed using both k-ε and DES models. Various secondary eddies near the corners and walls were captured by DES model which were not present in the results of k-ε model. The recirculation region in the cold aisle was well captured by DES as compared to k-ε.

Artificial neural network (ANN)-based prediction model was created for facility and rack level model to predict the rack air temperatures and other parameters affecting the thermal performance of the data center. The ANN model was trained based upon both experimental as well as the simulation results. The ANN models validated with the temperature variation less than 1.5 °C at all major locations inside the server room as compared to CFD results.

The artificial neural network (ANN) models can predict the thermal parameters affecting the performance of the data center within negligible computational time and resources as compared to CFD simulations. Therefore, ANN-based model can be utilized for real-time control of data center system for energy efficient thermal management.